THE VETERINARY RECORD

FOUNDED BY WILLIAM HUNTING, F.R.C.V.S., 1888.

No. 38. SEPTEMBER 16, 1944 VOL. 56

Effects of Mineral Deficiencies in the Diet of Livestock*

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In choosing the subject of the effects of mineral deficiencies in the diet of livestock I have probably, so to speak, bitten off more than I can chew; however, I would like now to make it clear that I do not intend to go into the details of mineral metabolism and that the subject matter of this paper is composed of facts which are already well known. The mineral nutrition aspect of animal husbandry is such a huge subject that it would be impossible to deal exhaustively with it in any one paper read at a meeting such as this.

The importance of minerals in a diet has only recently been rediscovered. Liebig and Chossat, about the middle of the last century, strongly emphasised the need for minerals in animal feeding. Chossat showed that poor bone in pigeons resulted when fed on a diet low in calcium and that they died after ten months when fed solely on wheat.

During the next two decades or so following the year 1842 continental authorities showed that skeletal formation in different species of animals was dependent on the amounts of calcium and phosphorus in the diet and that deficiencies could be overcome by feeding bone meal and other mineral supplements. For many years the mineral aspect of nutrition was ignored, but with the discovery of vitamin D in the year 1922 a new impetus was given to the study of mineral metabolism. It is now realised that in considering a ration for animals the mineral and vitamin content of the foods must receive attention in addition to the other digestible constituents, this being especially necessary for young growing animals and milch cows. To stress the importance of an ample supply of minerals at the expense of the vitamins would ultimately lead to vitamin starvation, which is as detrimental to health as mineral starvation.

The principal essential mineral elements necessary for body functions and which must be supplied in the food are Ca, P, Na, K, Cl, Mg, Fe and S. Ca, P and Mg are chiefly found in the skeleton, but a much higher percentage of Mg is present in the soft tissues than of Ca and P. Na and Cl are in the body fluids, K in muscle and iron as a constituent of the haemoglobin. Sulphur occurs in organic compounds, principally in proteins, as the sulphur containing amino-acids, cystine and methionine. In addition to these there are minerals which are needed in minute amounts known as the trace elements including iodine, cobalt, manganese, copper and zinc. There are others present in the animal body, *e.g.*, silicon, boron, bromine, aluminium, arsenic, nickel, fluorine, but it is doubtful if these have any necessary function. However, certain trace elements if present in excessive amounts in soil-water and plants produce toxic effects in animals, *e.g.*, fluorine, molybdenum and selenium.

CALCIUM AND PHOSPHORUS

Since calcium and phosphorus form over 90 per cent. of the ash of the body it is fitting that one should deal primarily with these important elements and since both of them are closely associated with each other in the body it simplifies matters if they are dealt with together.

In order to promote proper calcium and phosphorus nutrition these two elements must be present in sufficient amount, there must be a suitable ratio between them, and also the presence of vitamin D. The Ca/P ratio becomes of less importance with plenty of vitamin D in the ration, and there is more efficient utilisation of the amounts of the elements present. More vitamin D is required when the amount of either element or the ratio between them is sub-optimum. No amount, however, will compensate for severe deficiencies of either element. The desirable $CaO : P_2O_5$ ratio has been defined as being approximately 1 : 1.

It is well known that foods deficient in lime and phosphorus and also foods that have not got them in the proper ratio predispose to osteodystrophic disturbances, *e.g.*, rickets and osteomalacia, while it is an accepted fact that if a ration contains an excessive amount of phosphorus as compared with calcium, the calcium of the body reserves in the skeleton becomes used up, and defective bones are the result.

Much of our knowledge of the effects of phosphorus deficiency is due to Theiler and his co-workers in South Africa. They showed that large losses which occurred in both growing and adult cattle on the range were due to a low content of the element in the herbage as a result of a deficiency in the soil. A similar condition has been noted in other parts of the world, *e.g.*, certain districts in America where heavy rains contribute to erosion or where continued heavy cropping is the rule, possess phosphorus deficient soils. Also, protracted drought may precipitate aphosphorosis in range cattle. This was very evident in South Iowa during the great drought of 1934 when many cattle developed a condition, characterised by depraved appetite and stiffness, which was hitherto unknown.

There is much evidence to prove that an adequate phosphorus intake is directly concerned with breeding efficiency. Valuable experiments were carried out by du Toit and Bisschop of South Africa on the results of feeding bone meal to breeding cattle on phosphorus-deficient lands. To quote briefly: Cows and in-calf heifers were fed 5 oz. of bone meal daily and all growing and dry stock 3 oz. The calves received bone meal from nine months until two and a half years of age. Over a three-year period bone meal-fed cows had produced an average calf crop of 87 per cent. as compared to 56 per cent. for the controls. In the bone meal group 66 per cent. had three calves in three years while not a single cow among the controls produced a calf each year. The feeding of bone meal hastened sexual maturity and promoted regular breeding. High-grade bone meal appears to be the best phosphorus supplement for cattle and as it also ensures an adequate supply of calcium, it is valuable for young stock. Similar areas of calcium deficiency have been reported in other parts of the world.

Theiler, speaking of osteodystrophia fibrosa in the horse, says that the excess of phosphorus in the causal diet is absorbed into the blood stream and that its subsequent elimination imposes a drain on the calcium reserves in the skeleton. Skeletal tissue is absorbed and then rebuilt on a reduced scale. This results in a correspondingly light skeleton for which the reduced calcium resources are still sufficient and which is more or less completely calcified. But since the new fabric is lighter and more fragile, it is not sufficiently strong to resist traumatic influences or the normal strains of functional activities.

Osteodystrophia fibrosa (osteomalacia) may be produced in horses when the ratio of $CaO : P_2O_5$ is between 1 : 2·9 and 1 : 18; it is not produced, according to Kintner, when the ratio is 1 : 1·9.

Some authorities suggest that exostoses may be due to depletion in the mineral reserves of the skeleton; others are at variance with this view.

It is apparent that the density or strength of bone of horses and other animals is based on their mineral content and that the mineral content is influenced by the proportion of calcium to phosphorus in the animal's ration. Kintner, of the U.S. Army Veterinary Corps, from his experiments carried out on race horses regarding the calcium-phosphorus ratio, maintains that it is reasonable to assume that mechanical irritation applied to bone low in minerals may result in the proliferation of bone.

It has been demonstrated that diets rich in calcium and phosphorus favour the production of the condition of perosis or slipped tendon in poultry, which is due to a manganese deficiency, the availability of manganese in the intestinal tract being thereby greatly reduced. Lack of Ca in poultry, as in other animals, tends to produce poor calcification, especially if the supply of vitamin D is insufficient. A deficiency of Ca results in low egg production and imperfect egg shells.

Anoestrus in cattle is reported as being an indication of mineral deficiency, a low phosphorus or a wide calcium/phosphorus ratio retarding or lengthening the oestrus cycle.

A deficiency of calcium in weaned pigs results in anorexia, unthriftiness, inco-ordination of movement leading to paralysis, lack of growth and poor utilisation of food.

Rachitis is met with in pigs where the ration is deficient in calcium and phosphorus with lack of vitamin D. It is not seen in these animals where they are fed on a properly balanced diet and kept under good hygienic conditions. In connection with rickets in pigs, sometimes tetany is seen in healthy-looking pigs at about eight weeks old; they suddenly fall to the ground in a tetanised condition. Some fail to recover from these tetanic spasms, but those that do,

* Presented to the Veterinary Medical Association of Ireland, at Dublin, May 10th, 1944.

show in a few weeks evidence of rickets with enlarged joints, etc. A similar rachitic tetany has been recorded in indoor reared calves in U.S.A. The condition is not seen in calves with access to pasture or exposed to direct sunlight in yards.

Recently phosphorus in the form of dilute phosphoric acid has been employed successfully in the treatment of "stiff lamb disease" in Canada. The use of phosphorus in this case seems to be empirical as the exact nature of the disease is not yet known; however, it has an immediate and beneficial effect. It might also be well to mention here that calcium and phosphorus metabolism is influenced by the parathyroid hormone. The primary symptoms of parathyroid deficiencies are hyperirritability of the peripheral nerves and muscles with tonic and clonic contractions of the latter, constituting tetany.

Conditions associated with dysfunction of the parathyroid and in which there is disturbed calcium and phosphorus metabolism include:—

Parturient toxaemia due to a hypo-calcaemia.
Lactation tetany due to a hypo-calcaemia and hypo-magnesaemia.
Transit tetany of horses and cattle (said to be due to hypo-calcaemia).

Magnesium

Approximately 70 per cent. of the body supply is in the skeleton, the remainder being widely distributed in the various fluids.

There is an inter-relationship between calcium and magnesium; an excessive magnesium intake, *e.g.*, in certain waters or foods and calcium supplements like dolomitic limestone, is known to have a deleterious effect on calcium retention in the body. However, if calcium and phosphorus are plentifully supplied the ingestion of an excess of magnesium will not disturb calcium retention, though it may increase the requirements for calcium and phosphorus in the ration.

Lactation tetany, which occurs during the spring months in certain districts in cattle, is associated with a low blood calcium and magnesium, although, as already mentioned, tetany may be produced in other ways.

The recommended procedure to be adopted on farms where losses have occurred is to add 2 oz. of a mineral mixture containing 10 per cent. magnesium oxide to the daily ration during the late winter and early spring or to inject 500 to 700 c.c. of a calcium compound, containing some phosphorus and magnesium. If calcium gluconate is given alone it should be fortified by an intravenous injection of 50 to 100 c.c. of a 10 per cent. solution of magnesium sulphate.

A tetany with a low blood magnesium and normal calcium and phosphorus has been reported in calves fed exclusively on milk.

From the knowledge available at present, it may be assumed that domestic animals fed on the usual diets are unlikely to suffer from a magnesium deficiency, most roughages containing ample amounts for adequate mineral nutrition. Experimentally, Mg deficiency causes slow growth in chicks with convulsive symptoms.

Sodium, Potassium and Chlorine

These elements are found principally in the soft tissues and fluids of the body.

Concerning potassium, most foods contain ample amounts and therefore a deficiency of this element is unlikely to occur. Chicks, however, have a rather high requirement for potassium and a lack of this element has been shown in experimental studies to cause slow growth and high mortality.

In connection with sodium and chlorine most foods are relatively deficient in these elements and since a deficiency of one seldom occurs without the other, they are usually given together as common salt. There are no reserves of sodium and chlorine in the body; their excretion from the body may, however, be controlled by the animal when the food is deficient and so the detrimental effects of a deficiency may not arise for some time. An average-sized cow contains about 40 lb. of calcium phosphate and only 3 to 4 lb. of sodium chloride. In a 1,000-gallon lactation she secretes 30 lb. of calcium phosphate and 20 lb. sodium chloride and since a deficiency of calcium and phosphorus can be met temporarily from her body reserves, such is not the case with sodium chloride.

It is apparent, therefore, that milking animals should be provided with salt licks or rations to which salt has been added; this, I think, is not fully realised by stock owners in this country.

Salt, of course, is also necessary in small amounts for other animals including pigs and poultry, but cases of salt poisoning sometimes occur in these animals from feeding on household waste with a high salt content or giving excessive quantities of herring meal.

Sodium chloride deficiency produces slow growth in chicks and a tendency towards cannibalism in laying hens under certain conditions.

There is also evidence that a lack of sodium chloride causes or predisposes to contagious necrosis of the skin of camels in India and Somaliland, and that this condition can be prevented and in conjunction with local treatment cured, by administering 5 oz. of salt per day.

Iron

Iron, although present in very small amounts in the animal body, is absolutely essential, since being a constituent of the haemoglobin it is necessary for the functioning of every organ and tissue of the body. For haemoglobin synthesis a small amount of copper is necessary though it is not itself a constituent of the haemoglobin. This function of copper establishes it as an essential mineral.

Nutritional Anaemia.—This disease of unweaned pigs, characterised by white scour at a few weeks old with pallor of the skin, is usually described in connection with an iron deficiency; it is, however, closely associated with copper and cobalt deficiency. The condition is amenable to treatment by dosing the bonhams individually with ferrous sulphate. Nutritional anaemia usually runs concurrently with a vitamin A deficiency. It should be noted in connection with pigs that mineral deficiency and avitaminosis are closely allied to each other and that it is very difficult to draw a definite line of demarcation between them. A deficiency of both sets up a syndrome of symptoms, often classed as separate diseases, which are really due to improper pig husbandry including defects in feeding, housing and general sanitation. If young pigs get a good start in life they will be more resistant to infections when weaned and better able to withstand unsatisfactory conditions of management later in life.

To enable young pigs to grow into healthy virile animals they should be reared in a suitable environment, paying particular attention to fresh air and exercise, sunlight and access to pasture. The more unnatural and artificial the rearing methods the higher will be the incidence of disease.

Iron and copper deficiencies have been responsible for anaemia in chicks, but practical rations contain plenty; their addition to the diet is, therefore, unnecessary; in fact iron salts may produce perosis.

Trace Elements

These occur in minute amounts in plants and animals and are of significance in the nutrition of both. According to Mitchell, the amount taken up by the grasses depends not only upon the total amount in the soil, but also on the species of grasses and the availability of the trace element as determined by various conditions, *e.g.*, acidity or basicity. The amount of trace element available to the plant may also increase with the weathering and decomposition of the rock particles forming the soil.

To quote Green, of Weybridge, *re* the significance of trace elements in relation to diseases of animals—the physiological function of some elements may be quite different in plant and animal economy, *e.g.*, the requirements for iron and copper of the plant are below those of the animal in the sense that a pasture may be growing luxuriantly and yet induce anaemia in the grazing animal. On the other hand, boron is a limiting factor in plant health, but, if essential for animal health at all, the smallest quantities ever found in plants appear to be sufficient in that no "boron deficiency disease" has so far been recorded in animals.

Copper

A deficiency of this element in the soil is responsible for diseases both in plants and animals in certain countries. A deficiency of Cu is responsible for "lecksucht" in cattle grazing on Cu deficient pastures in Holland and for "falling disease" in cattle along the South Coast of Australia. Sheep are similarly affected, the milk of both species being low in Cu. "Enzoötic ataxia" of lambs, which occurs in these areas, and "swayback," an analogous condition, can be prevented by giving Cu to the ewes during pregnancy. The exact cause of "swayback," however, is unknown and it appears that the disease is not due to a deficiency of copper alone since it may occur on land where the copper content is normal.

Nutritional anaemia of pigs is associated with a Cu as well as an Fe deficiency.

Cobalt

This element has been shown to be essential for ruminants and a deficiency is responsible for "Grand Traverse" or Lake Shore disease of cattle and sheep in Michigan, salt sickness in Florida, Coast disease of sheep in South Australia, enzoötic marasmus of cattle and sheep in West Australia, Bush-ill and Morton-Mains disease in New Zealand. These conditions can be cured and prevented by giving 0·1 mg. of soluble cobalt daily to sheep and 0·5 to 1 mg. daily to cattle. These trace element deficiencies may also be corrected by top-dressing the deficient pasture with a few pounds per acre of cobalt or cobalt and copper salts, since in South Australia a deficiency of copper was responsible for the ataxia and a combination of cobalt and copper prevented the condition.

"Neck-ail" in Massachusetts, "nakuruitis" in Kenya and "vinquish" in Scotland are now considered to be connected with

a deficiency of cobalt, iron deficiency originally being thought to be the aetiological factor.

Manganese

This has been shown to be essential for the animal body, being associated with growth rate, skeletal metabolism, ovulation and development of the foetus. In intensively reared poultry a deficiency produces perosis or slipped tendon, an anatomical deformity of the tibial-metatarsal joint. Hens on a manganese deficient diet produce eggs of low hatchability and show micromelia and deformed embryos. However, most plant foods contain sufficient manganese and so a deficiency in animals due to this element is rare.

Zinc

Zinc is widely distributed in plants, therefore no deficiency is likely in animals fed on the usual rations.

Boron

It is unlikely that a boron deficiency may occur naturally in animals.

Iodine

Iodine deficiency is an area problem, the soil, water and crops being low in this element in certain districts. A deficiency causes enlargement of the thyroid gland—goitre. Pregnant animals suffering from an iodine deficiency produce hairless dead or weak offspring with marked enlargement of the thyroid gland. Where goitre is due to an iodine deficiency, the addition of iodine to the ration is beneficial.

The three elements selenium, fluorine and molybdenum are responsible for pathological changes when ingested in excessive amounts.

Selenosis has been noted principally in S. Dakota, U.S.A., where it is responsible for so-called "alkali disease" characterised by retarded growth, loss of hair from the mane and tail of horses and sloughing of hoofs. A more acute form of the disease occurs in Wyoming where it is known as "blind staggers."

Molybdenosis or "teart" occurs in certain areas in England—Somerset, Gloucester and Warwick—whereby the grazing animals develop scour. Only ruminants become affected, dairy cows more so than fattening cattle; sheep are less susceptible. The administration of copper sulphate has proved to be beneficial, while teartness can be reduced by suppressing clovers and other legumes in the pasture which absorb more molybdenum than the grasses or by applying fertilisers which render the soil acid and so lower the availability of molybdenum.

Industrial fluorosis has been encountered in various parts of England among cattle grazing in the neighbourhood of factories producing hydrochloric acid, enamel and aluminium and in the vicinity of brickworks. It is a surface contamination of the soil and herbage, the fluorine being deposited in the direction of the prevailing winds. Affected animals show lameness, pain on manipulation of the bones, together with enlargement of these, cachexia and mottling of the teeth.

Mineral Requirements of the Various Species of Domestic Animals

As an introduction to this heading it might be well to consider a few points regarding mineral nutrition in general, with special reference to Ca and P.

In choosing rations for their calcium phosphorus content consideration should first be given to supplying these minerals as far as possible by selecting those feeding stuffs that are rich in the elements required and that have been grown on fertile soil; failing this, resort should be made to feeding a mineral preparation containing bone, *e.g.*, fish meal or bone meal, or a mineral mixture of chemical substances in the form of licks, etc.

Further, according to the nature of the mineral ingredients in a food, it is either acid-forming or alkali-forming. Sodium, calcium, potassium, magnesium and organic acids are alkali-forming whereas sulphur, phosphorus and inorganic acids give rise to acid conditions. An ideal ration should be either neutral or alkali-forming. Meadow hay, grass, root crops, silage, milk and its by-products, soya and earth nut cake are moderately alkali-forming, leguminous crops are strongly alkali-forming, whereas cereals, wheat offals, peas, beans, meat meal and fish meal are acid-forming. This, therefore, explains why chalk is so necessary an addition to the normal diet of pigs and poultry, since the foods for these animals are acid-forming.

The qualities which determine the feeding value of supplements depend on the Ca and P content, the fineness of division and the freedom from harmful impurities. In regard to the last mentioned, the injurious effects of rock phosphate as a mineral supplement have been attributed to its fluorine content, the fluorine causing a decreased retention of phosphorus in the body. The practical lesson to be learned from this is that mineral compounds containing fluorine may actually help to produce osteomalacia rather than prevent it. Fortunately, it is now possible to remove the fluorine from this source of P in making it a safe product to feed.

In connection with the indirect method of supplying animals with minerals by manurial treatment of the land, stress should be laid upon soil analysis, in order that fertilisers may be applied judiciously. It is well known that mineral rich crops cannot result from growth on impoverished soil. Even when the mineral composition of the plant is known, however, the availability of the ash content is to a certain extent dependent on the form in which it is present and on the associated minerals. Phosphorus when combined with phytic acid and oxalic acid retards the assimilation of calcium. It is evident that there is still much to be learned *re* the availability of the various fractions of the plant ash.

Grass is valuable in usually containing more Ca than P. Most cereal foods and cakes which form a major part of many rations in normal times are richer in P than in Ca and are best fed along with grass, or other food having a suitable Ca/P ratio. Moon states that although the mineral content of pasture is greater on manured than on unmanured land, care is necessary in the application of artificial manures if the best results are to be obtained. Overliming of the land is dangerous. It is said that lime reduces the assimilation of manganese from soil and that it may produce diseased conditions due to a manganese deficiency. Deficiency of iron and boron may also be induced by overliming, the former resulting in chlorosis. In calcareous soils molybdenum seems to be highly available to plants.

On soil deficient in phosphorus it has been shown that, although manured with phosphate, very little of the phosphorus becomes available to the herbage and so to the grazing animals. If, however, the manuring is repeated or heavy dressings are applied until the soil becomes overcharged, the full manurial dressing becomes available to the plant and, therefore, indirectly to the animal.

An interesting point in connection with the depletion of the soil of minerals is evidenced in Australia regarding the incidence of the copper-deficiency disease enzoötic ataxia—a disease of the unweaned lamb characterised by ataxia of the hind limbs. It has been indicated that the incidence progressively increases with time and with the increased rate of stocking which follows clearing of the country and development of improved pastures. At one particular part of the country it became manifest only after the country had been stocked for some 15 or 20 years and it was not until about 30 years ago that the disease became prevalent at all. In another case, property purchased to establish a farm was reported to have carried sheep satisfactorily in its virgin state for a period of 80 years. The disease first made its appearance there in 1930 and in 1931, 35 of 86 lambs developed ataxia. In 1933 all the progeny of 213 ewes were affected.

These facts clearly demonstrate how animals bring about the depletion of minerals in the soil and it is evident, therefore, that since the demand of the animal's system is great, there is a corresponding depletion of minerals in the land, hence the necessity of maintaining grassland in good fertility, of soil analysis and the application of fertilisers.

It is difficult to ascertain the theoretical mineral requirements of animals. To arrive at satisfactory mineral standards for livestock it is necessary to underestimate rather than overestimate the amounts of minerals utilised in the ration by the animals. It is assumed that the maximum amount of the mineral constituents capable of being utilised is in the region of 30 to 40 per cent.

With reference to the mineral requirements of the equine species, the horse is longer lived than other species, not being a food producing animal, and consequently nutritional disturbances due to lack of minerals and also of vitamins in the food become more apparent. The need for Ca and P is greatest during early life. The need diminishes as the animal reaches maturity at about the end of the third year.

Brood mares need plenty of Ca and P for reproduction and for nursing the foal. There is evidence to show that even mature horses of all ages may be adversely affected when there is a deficiency of these minerals. For proper assimilation and utilisation of Ca and P vitamin D is required, the horse being similar in this respect to other animals.

Mineral deficiencies may result in disturbances of growth, breeding, bone and nerve metabolism.

It is probable that lameness involving the joints with rarefying lesions in the joint cartilages is related to a vitamin A deficiency and improper mineral balance or default in the Ca/P ratio. This was brought to light by Mitchell of the (Dick) Veterinary College in his studies on lameness in horses.

The Ca/P ratio is important, since the horse appears to be very susceptible to the effect of an excess of P over Ca in the feed. A ration too high in P causes a disturbance of the mineral metabolism

resulting in osteodystrophia fibrosa. The Ca/P ratio should be about 1 : 1. An excess of phosphorus may be given to horses by feeding excessive amounts of oats and bran. In hay Ca exceeds phosphorus, thus liberal amounts of hay are necessary for horses fed on a grain mixture of oats and bran. The ratios vary in different types of hay, therefore the type of hay must receive attention. However, good meadow hay from good land with many good grasses and clovers may be taken as having sufficient amounts of Ca present.

Ling suggests that the calcium content of the dry matter of hay should be not less than 1·07 per cent. to supply the needs of animals and that for every ton of hay removed about 41 lb. of ground limestone equivalent is removed from the soil. Regarding phosphoric acid, the dry matter of hay should contain at least 0·5 per cent. The majority of samples of hay have levels below these figures, the chief causal factor being repeated hay cropping without the application of fertilisers. Certain amounts of lime and phosphates do get back into the land through the manure from animals, but these are small with young growing and breeding animals and in dairy cattle, the demand for minerals by these animals being high.

The actual requirements of Ca and P in horses are not yet known ; in fact, very little consideration has been given to research in equine nutrition and more is definitely required in this important subject.

Regarding the dairy cow, the chief minerals concerned are sodium, calcium and phosphorus. The composition of the milk remains the same whether the ration contains sufficient minerals or not. The lactating cow is capable of drawing on its reserves to maintain an unimpaired milk yield. Heavy yielding cows at the peak of their lactation are usually in a negative Ca/P balance, *i.e.*, they give out more mineral matter, especially Ca, in their milk than they assimilate from their food. This involves no harm, however, as the cow is capable of storing minerals in her bones to tide her over the period of a heavy lactation and her reserves can be subsequently replenished during the next dry period. It has been estimated that a cow of average weight requires for maintenance about 1½ oz. lime and ½ oz. P_2O_5 daily ; for every gallon of milk ½ oz. to ¾ oz. lime and ½ to 1 oz. P_2O_5. A gallon of milk contains roughly ¼ oz. CaO and ½ oz. P_2O_5. It is apparent, therefore, that the drain on the skeletal calcium and phosphorus of the cow over the lactation period must be very great.

A shortage of lime can be made good by feeding good clover hay or by the addition of about 2 oz. daily of bone meal which is also a source of phosphorus. For high yielding cows a mineral supplement recommended is two parts by weight of salt, one part ground chalk and one part of bone flour—3 lb. of this to every 100 lb. of concentrated food.

Provided calcium and phosphorus are adequately supplied, the Ca/P ratio seems not to be an important consideration in the nutrition of dairy cattle.

It has been found that in cows fed on hay with a low lime and protein value and where the supplementary ingredients were also deficient in these substances, the quality of the milk was adversely affected (low in solids not fat). Sterility, it is said, may also be due to the low lime content of hay when accompanied by low phosphoric acid.

Cereals, though containing sufficient phosphorus, are deficient in lime and chlorine ; in fact, the oil cakes and leguminous grains tend to have too little lime and chlorine for the needs of the animal. Roots and tubers are poor in minerals. The leaves and stems, however, in contrast to the seeds of crops, are rich in these elements and so greenstuffs and the various types of hay are a natural supplement to concentrates used in feeding.

Regarding phosphorus, it is very unlikely that any well balanced ration will be deficient in this element. Most roughages are relatively low in phosphorus, but the phosphorus content of cereals is high and in high yielding cows the concentrate required to balance the protein of the ration will usually be rich in phosphorus.

Every effort should be made to improve the soil by drainage and suitable manuring so that mineral rich plants can be grown readily as forage crops, or for hay or silage.

Calves.—The chief minerals concerned for indoor-fed calves are calcium, phosphorus, magnesium, chlorine and sodium. Enough trace elements will usually be supplied in the foods, especially if greens are fed. However, in " pining areas " it may be necessary to supply Fe, Cu and Co to pregnant cows and the young calf.

Miller mentions some guiding principles to be observed *re* mineral nutrition in calves :—

1. Milk does not contain sufficient minerals for normal growth and development.

2. Most meals and gruels made from crushed seeds and their by-products contain enough phosphates but are poor in calcium (and often in magnesium).

3. Good quality hays have adequate minerals in blades and stems, but not in flowering heads.

4. The newly born calf nearly always obtains from its dam enough Ca, P and Mg *in utero* to enable it to be born with calcified bones

5. Any consideration of minerals only, without due consideration of vitamin D and sunlight, is useless.

Sheep.—The question of mineral nutrition has occupied and is occupying a large role in modern research work. I have already referred to the well-known deficiency diseases of sheep.

With sheep, the hay or green food in the diet will usually ensure a sufficient supply of the required minerals.

From recent investigations carried out, there seems to be a close association between mineral deficiency in lambs and their susceptibility to parasitic troubles. Good results have been obtained by combining anthelmintic measures with a mineral supplement containing a number of the trace elements.

Pigs.—The minerals likely to cause trouble in pigs when deficient in the ration are Fe, Cu, Ca, Mg, P and I.

In pigs it is seldom that minerals alone are lacking, there is usually an accompanying vitamin deficiency. Nutritional anaemia is due to an iron deficiency and rickets to an improper balance of Ca and P, but many factors are really concerned. Attention must be paid to providing the bonhams with a properly balanced diet and good hygienic conditions. If possible the pigs should have free access to pasture at an early age.

In relation to anaemia, the reserve of iron in the young pig at birth depends on the mother having obtained a sufficient supply in her diet and no amount of iron added to the diet of the sow during suckling will cure the condition unless the bonhams get iron.

In regard to rickets and osteomalacia, a suitable ration with a mineral supplement and cod-liver oil should be provided, together with proper management.

Some of the mineral rich foods that may be used in pig feeding include commercial meat meal, meat and bone meal, skim milk and access to good pasture. Bacon pigs receiving 10 per cent. of animal protein food require no mineral supplement. When feeding vegetable protein to pigs kept intensively it is advisable to add to the ration a 2 per cent. mineral mixture consisting of three parts of finely ground chalk and one part salt. Where cooked potatoes form a large part of the ration it may be safer to use a mineral mixture containing phosphate as well as lime and chlorine, *e.g.*, one part bone flour, one part ground chalk and half part salt. Salt may be omitted when swill forms the basis of the diet.

A deficiency of Ca is also said to be a possible cause of fits in pigs which have been described as pre-rachitic symptoms.

Dogs.—There are no very accurate data on this subject. Apart from salt, it seems likely that only Ca and P need receive consideration, the other essential minerals being present in sufficient amounts in the usual foods.

Rickets in dogs is of the low phosphorus type and this condition is probably due to faulty utilisation of the phosphorus present and not to an absolute deficiency. Parathyroid extract is reported to be beneficial in these cases.

A ration consisting solely of meat or of muscle meat plus cereals is apt to be deficient in calcium and this may be rectified by inclusion in the diet of bone meal or raw or cooked bones. These latter are also good sources of phosphorus, but usually there is a sufficient supply of this element in the food, *e.g.*, if dog biscuits are fed.

If the diet consists largely of flesh or a high proportion of cereals Linton recommends the addition of 0·5 to 1 per cent. salt to the diet. Greyhounds have been given 2 to 3 per cent. of the ration.

Liberal amounts of minerals are necessary for pregnant and nursing bitches and puppies.

Bones, sterilised bone flour, bone meal or milk are necessary for bitches if the diet consists largely of beef, horse flesh or wheat flour biscuits.

For puppies during the suckling stage sufficient minerals are obtained from the milk. Milk, however, is deficient in Fe, Cu, Mn and Co, but this fact is of little consequence since the animals are born with a store of these trace elements which satisfy their needs until weaning time.

During the weaning stage attention to mineral additions might have to be considered in the form of bone or blood meal if the diet consists mainly of cereals or cereal flour.

Mineral Requirements of Poultry

Halnan states that for practical purposes the mineral requirements of the chick can be satisfied under normal conditions of feeding by :—

1. Supplementing the mash with 0·5 per cent. common salt, 1 to 2 per cent. ground chalk or limestone and 1 to 2 per cent. cod-liver oil.

2. Large amounts of fish meal, bone meal or sterilised bone flour or other high phosphorus containing substances, should not be included for chicks under eight weeks, owing to the tendency of these substances to produce perosis.

3. After eight weeks bone meal may be included if desired.

Minerals and Egg Production.—The minerals of importance for egg production include Ca, Na and Cl, S and Mg. Ample Mg and S

is generally available in the ordinary diet. Ca, Na and Cl are limiting factors and the addition of these as supplements to poultry diets resulted in improved egg production. The beneficial effect on egg production following the inclusion of animal protein is largely due to its salt content, and so the limiting factor in egg production is lack of minerals rather than a protein deficiency.

In practice 0·5 per cent. common salt should be added to the cereal mash and grain diet and allow the birds access to limestone or oyster shell. The need for salt disappears if fish meal or meat meal forms part of the mash.

Requirements for Egg Production.—The amount of calcium in the shell of an egg is 2 to 5 grammes, or just over one-fifth of an ounce. This calcium is readily taken from the supplies of the element in the food. A bird in lay consuming about 130 grammes of food a day must have 2 to 4 per cent. calcium carbonate to provide for shell formation. The need for calcium carbonate by the laying hen can best be supplied by allowing 1 oz. of oyster shell or limestone grit for every four eggs laid.

With reference to rickets in poultry, small amounts of cod-liver oil are often added to chick mashes to prevent the condition. If "leg weakness" appears in spite of this addition the oil is usually blamed. It should be remembered that a lack of minerals may be the cause. If a chick diet contains less than 0·7 per cent. Ca and 0·4 to 0·5 per cent. P rachitic symptoms are sure to arise; under such circumstances extra cod-liver oil will not effect a cure.

In general the mineral most commonly deficient in chick mashes is calcium and this can be overcome by supplementary allowances of ground chalk or limestone flour or by allowing the chicks to have free access to fine limestone grit or oyster shell.

Excess minerals may, however, have detrimental results. A useful guide recommended by Black is that chick rations should contain approximately 1·1 per cent. calcium and 0·7 per cent. phosphorus.

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Discussion

Professor SHEEHY opened the discussion as follows: "The functions of many of the inorganic or mineral items of a diet, as Mr. O'Connor has told us, are well known, and the discovery and demonstration of these functions have formed the subject of many brilliant pieces of research. There are other minerals, however, which are known to be necessary for metabolism, but the functions of which are obscure. Even in the latter group, however, the clinical and gross symptoms resulting from their absence from the diet are in most cases familiar. Now a complete or almost complete absence of any essential mineral ingredient —whether it be one such as calcium which is required in considerable quantity, or copper, a mere trace of which suffices—produces pronounced disorders and pathological changes which are easily recognisable. There is, so to speak, definite evidence of something being radically wrong. On the other hand, a mild deficiency is far more difficult to diagnose in that the animal may show no definite symptoms; it may, however, and usually does cause unthriftiness and the accumulative effect of a mild deficiency may bring about disorders, the occurrence of which is not easily traceable to the dietary deficiency. While we have evidence of pronounced mineral deficiency in livestock feeding in this country, the greater number of instances of mineral shortage are of the mild form, the importance of which is likely to be overlooked because of the absence of casualties or of a diseased condition calling for veterinary attendance.

In reference to the relationship which, for best results, must exist between certain mineral ingredients, Mr. O'Connor gives the optimum ratio of calcium to phosphorus as 1 to 1, but he gives the result of an experiment in which, in the case of the horse, a ratio of 1 to 1·9 gave satisfactory results. This coincides with my own experience on pigs in which calcium to phosphorus ratios of 1 to 0·5, 1 to 1, 1 to 1·5 and 1 to 2 gave like results, provided an adequate amount of vitamin A was provided in all cases. The fact that administration of copper prevents the injurious effect of excess of molybdenum would suggest the existence of an optimum ratio between these two minerals. Again as regards perosis in fowl where the causative factor appears to be an imbalance between calcium and magnesium, Dr. Senior of my laboratory has been able to prevent the occurrence of perosis by abstracting some of the calcium phosphate from a particular diet which gave pronounced perosis.

I feel that Mr. O'Connor has unduly emphasised the effects of acid producing and alkali producing diets. Actually it is difficult, even by the ingestion of a considerable quantity of acid producing or alkali producing salts, to shift the hydrogen ion concentration of the blood to any appreciable degree. I think we may depend on the compensatory mechanism of the body to maintain stable conditions and not worry unduly about the acid producing effect of cereals, meat and fish meal. The occurrence of acidosis or ketosis is a condition apart, which is usually associated with some specific metabolic disturbance.

Coming to the mineral deficiencies which occur or are likely to occur in this country, we realise that house-fed pigs and poultry receive a diet which consists chiefly of cereals, cereal products, tubers and roots, in all of which the proportion of calcium is very low; of phosphorus there is usually sufficient and frequently an excess. The best way to prevent calcium deficiency in these cases is to feed supplementary foods high in calcium, namely, milk, fish and meat meal and green forage. In the absence of these foods an inorganic mineral supplement is necessary. Such inorganic mineral supplements are unnecessary, however, if adequate quantities of fopds high in calcium are supplied. There is one exception, namely, that of laying fowl which for obvious reasons must have limestone grit or a suitable substitute, *ad lib.* Another special case is presented when bonhams are confined to a house with concrete or other type of floor which prevents them from access to the earth. The administration of iron salts containing a trace of copper to the bonhams prevents the onset of anaemia which, however, does not appear if the bonhams have access to earth preferably by running on pasture, even if only for a few hours daily, with their mother. In all cases of pig and poultry feeding except where the supply of milk or of fish meal is adequate the addition of salt to the meals in the proportion of 1 lb. to the cwt. is necessary for best results. A shortage of salt causes unthriftiness and low productivity. The mineral supply of house-fed heavy milking cows and of immature horses—under 5 years old—must also receive special consideration. The likely deficiencies are those of calcium and sodium chloride or salt. A salt lick in the manger or the addition of salt to the food" is essential. Cows giving more than four gallons of milk daily are likely to be in serious negative calcium balance and although the rectification of this balance is difficult while heavy milking obtains, nevertheless the giving of foods rich in calcium or of inorganic calcium supplements reduces the degree of negativity in the daily balance. Meat meal is often fed to dairy cows as a source of protein with excellent results, and incidentally it provides the necessary calcium. I suggest the feeding of good quality meat and fish meal to young horses for a similar purpose. As we know, these foods are disliked by horses to begin with, so in the case of cattle, but once horses become accustomed to them by gradual introduction they relish meat and fish meal of good quality. In the absence of such foods an inorganic calcium supplement such as 1 to 2 per cent. of ground limestone specially prepared for feeding is, unless the hay is of very good quality or unless green forage is provided, necessary to prevent, in the house-fed young horse, many of the skeletal and functional disorders so common in the equine. For outfed stock much of our old pasture land is deficient in salt and the provision of a salt lick is advisable for animals confined to such land. Of calcium and phosphorus deficiency we have evidence over a considerable area of our soil, and presumably from the effects observed on cattle and sheep the herbage in many cases is deficient therein. The remedy here consists in the application of lime and phosphate to the land and there is general evidence that on well manured farms the progress and the health of stock is superior to those on farms indifferently managed as far as manurial dressing is concerned. Hill farmers, for instance, who have suffered from deficiency disorders and serious casualties among their flocks and who have in the past been compelled to send some or all of their young stock to the lowlands for the winter, find that the fertilising of their land with lime and phosphate has solved most of their nutritional problems as far as sheep are concerned. It is, of course, realised that the manuring not only improves the quality but also increases the quantity of the herbage available.

Mr. O'Connor has referred to the quality of hay, which is the food on which cattle and horses so largely rely in winter for their mineral supply. Our experimental work with hay has demonstrated the vital difference between material which is properly cured and that which, in the making, has suffered severe weathering for weeks in the swath and windrow. Severe weathering and the effects of rain, wind and dew seriously reduce the assimilability of the calcium in the hay. This is a very serious matter where, as in the case of horses, milking cows and calves, hay constitutes the chief source of calcium and other minerals in winter. Among other differences which I observed in two groups of calves receiving well made and weathered hay respectively was the slowness of the group eating the latter to replace in spring the old coat of hair by new growth.

That there occur in this country unsuspected local cases of mineral deficiency I have no doubt, and one of your own members recently reported favourable results in the treatment of unthrifty stock in portions of Co. Kerry by administration of iron, copper and cobalt salts. One would wish to see the country so supplied with a veterinary service that each locality would, in as far as the health of livestock is concerned, be the responsibility of a particular veterinary surgeon who would be employed as part of an organisation functioning in such a fashion that not alone would there be a desire on the part of the local veterinarian to detect and report on such matters, but that full facilities would be provided to have all such matters which limit livestock productivity investigated.

I propose a hearty vote of thanks to Mr. O'Connor for his excellent paper.

Professor NICHOLSON, who followed as the second opener of the discussion, said: I should like to refer very briefly to some aspects concerning the metabolism of calcium and phosphorus.

Perhaps even more than an absolute deficiency of either, the Ca/P ratio in the diet requires careful consideration, for if this is incorrect there will be faulty absorption of both. This is due to the fact that in the intestine they combine with the formation of the comparatively insoluble calcium phosphate which is not readily absorbed and which will, therefore, pass out in the faeces. It thus comes about that if there is an excess of phosphorus in the diet, the absorption of calcium will be low and *vice versa*. Absorption of these minerals is greatly assisted by anything which helps to keep them in solution, so that where the absorption of either is at fault, the diet should be of an acidifying nature or, put the other way round, in conditions of deficiency of these salts, alkalis should be avoided. In the case of a calcium deficiency, calcium chloride or calcium lactate would be the salt of choice because of their acidifying effect, but in this connection it should be mentioned that the administration of calcium chloride is not necessarily followed by an increased absorption of calcium since there is evidence that the salt is split during the process of absorption, the chloride only being absorbed and the calcium left behind in the intestine in the form of the carbonate which is excreted in the faeces. Similarly, a faulty digestion and absorption of fats will also affect the absorption particularly of calcium owing to the formation of insoluble calcium soaps which arise from the combination of calcium and fatty acids if they are present in the lumen of the intestine.

It is in assisting the absorption of calcium and phosphorus that vitamin D is so important, for calciferol prevents the loss of these minerals in the faeces, mainly by ensuring that there is a suitable reaction in the upper part of the duodenum which in any case is acid and is the place from which these minerals are absorbed. The vitamin, of course, also assists in bone formation by activating the enzyme phosphatase which is normally present in actively growing bone and whose function it is to convert organic phosphorus into the inorganic form, thereby enabling it to be laid down in bone as calcium phosphate.

To turn now to a brief examination of calcium and phosphorus in the blood. Here we have to deal not so much with the minerals themselves as with ionisation, for it is the ions, particularly calcium ions, which are required for such things as the clotting of blood, the maintenance of the irritability of muscle and nerves, etc. That it is the ions and not the minerals which are

important is shown by the fact that calcium can be equally well replaced by strontium; incidentally, sodium can be replaced by lithium and potassium by rubidium. Again we find that the positive calcium ions and the negative phosphorus ions bear a reciprocal relationship to each other in the circulating blood so that an increase of one leads to the removal of the other either by its excretion in the urine or its precipitation in bone. It follows, therefore, that the ratio between them must be more or less exactly maintained, in this case as 2 is to 1. This appears to be the function of the parathyroid glands, for their removal causes the withdrawal of calcium from the blood both by precipitation in bone and excretion in the urine. Excess of parathyroid activity has a precisely opposite effect and is followed by a withdrawal of calcium from the bones and its increase in the blood. The parathyroid function is mainly exercised by varying the ease with which the blood plasma holds or lets go of its contained calcium and phosphorus, or in other words, altering the solubility of calcium and phosphorus in blood plasma. This raises the extremely interesting question as to the form in which calcium and phosphorus are present in the blood. Many suggestions have been made, but perhaps the most attractive is that plasma is a saturated solution of calcium phosphate. This would explain why calcium phosphate is not withdrawn from the bones which, after all, may be regarded as being in direct contact with the blood, so that unless it were a saturated solution, it would dissolve out calcium phosphate. But there is at least one difficulty in this assumption which is that, at any rate *in vivo*, calcium will precipitate for salt solution with a phosphate and bicarbonate content similar to that found in blood plasma. This has led to the idea that there is some agency which holds the calcium in the blood and there is every indication that the blood proteins are responsible for this, at least to the extent of 3 to 5 mg. calcium per 100 ml. serum. There is little doubt, then, that the proteins permit the blood to hold more calcium in solution than would otherwise be the case, so that they also must be taken into account when dealing with questions of blood calcium.

It is evident that for the correct metabolism of calcium and phosphorus many factors come into play. There may be an absolute deficiency or imbalance but disturbance of health and even serious disease may also arise which is due, not to a deficiency, but to some interference with the reactions associated with these elements. In other words, we must clearly distinguish between true deficiency diseases and true metabolic diseases.

This is well illustrated when considering the question of tetany. Clinically this takes various forms, but the obvious finding in all cases is a reduction of the total calcium in the blood. This, however, must not be taken to indicate that there is a deficiency of calcium in the diet or even in the animal; it is simply and solely a question of the amount of available calcium in the blood stream.

Broadly speaking, two types of tetany may be recognised; the first associated with an alkalosis and the second with some disturbance or disease of some organ or tissue concerned with regulating the blood calcium level.

Anything which raises the *p*H of the blood above 7·6, such as hyperpnoea, persistent vomition, the excessive intake of alkalis, etc., is liable to produce symptoms of tetany. The reason is that the amount of calcium in the blood increases in direct proportion to the hydrogen ion concentration provided that the bicarbonate remains constant. Thus, when there is a diminution of hydrogen ion concentration, shown by a raised *p*H, it will be followed by a decrease of calcium ion which may be so great as to cause the total blood calcium to fall below about 7 mg. per 100 ml. when clinical symptoms of tetany will appear.

In the second case, tetany is readily produced by the removal of the parathyroid glands, but there are other types of typical tetany in which there is no evidence of a failure on the part of the parathyroid. This is so particularly in grass tetany. In this condition as well as evidence of a disturbance of calcium metabolism there is also evidence of some accompanying metabolic disorder as shown by the presence of ketone bodies in the urine. There is also evidence, at any rate in dogs, that calcium and carbohydrate metabolism are closely associated, for the administration of lactose increases the total blood calcium and the reverse is also the case—the administration of calcium chloride increases the blood sugar. It is also the fact that many cases of tetany are greatly assisted by the liberal administration of glucose, so that I think the question deserves further investigation.

Finally a word on magnesium. There is little evidence that animals ever suffer from a deficiency of this mineral under natural conditions. There are, however, cases in which the amount of magnesium in the blood is less than is normally found, as, for example, in grass tetany, but to conclude that this reduction in blood magnesium is the cause of disease is, I think, in no way justified. The argument that some of these cases respond to the administration of magnesium salts does not help, for the fact is that following the administration of magnesium in the doses usually employed, the blood calcium and not the blood magnesium rises. Surely, a more reasonable suggestion is that the body is running short of available calcium and since calcium and magnesium follow a very similar metabolism, in order to conserve calcium as far as possible magnesium is used first. This will stave off disaster for a time and it also explains why many apparently normal animals show a low blood magnesium content but no symptoms of tetany, these only appearing when the total blood calcium falls below the danger mark.

Colonel DOHERTY: The relationship between soil fertility and animal fertility was a very close one; we could, with great advantage, combine our knowledge about both; if we skimmed off what was theoretical, accidental and coincidental and submitted the combination to a process of distillation, it was possible to obtain the essential oil of truth for the guidance of stock breeders.

The foods used for farm livestock, in the house and on the pastures, depended on the fertility of the soil for their food value. Every functional activity of the body—reproduction, growth, performance of work, etc.—depended on food plants nourished by a fertile soil.

It was easy to find examples of the manner in which the ordinary activities of the body were governed by food; it was not usual, however, to associate the functional activity of the reproductive organs of breeding animals with the quantity and quality of the food they ate. Yet the practice of raising the nutritional level of breeding ewes before tupping had persisted for many years with a view to raising the fertility rate. The manner in which the fertility rate of cows could be lowered by conditions of soil deficiency was well known to cattle breeders in many countries. These examples could be multiplied.

This intimate connection between soil fertility and the fertility of breeding stock directly affected the profits of the dairy farmer. The reduced earning capacity of a dairy cow that did not produce a calf each year required no emphasis. Fifty years ago the Danes, who had organised dairy farming as their national industry, recognised that infertility in their cows seriously interfered with profitable production. A search for the cause of the wastage revealed an organism which had the ability to multiply rapidly in the bovine uterus under certain conditions. When conditions were favourable infertility resulted; when conditions were unfavourable, although the organism could be demonstrated in the foetal membranes, fertility was not interfered with.

We could not suppose that this organism, which had become closely linked with bovine infertility, suddenly came into existence when first seen under a microscope. We did know, however, that it suddenly became of economic importance when large scale milk production necessitated intensive methods of cattle feeding. It was reasonable to suppose, therefore, that altered systems of cattle husbandry created conditions of nutrition favourable for the rapid multiplication of the bacillus first identified by Professor Bang.

As it had been demonstrated that high and low nutritional levels could directly affect the reproductive organs in non-pregnant females, it was reasonable to suppose that the reproductive system in pregnant females was subject to similar influences. The degree of resistance to invading organisms in any part of the body had always been closely identified with nutritional levels.

Disease causing organisms depended for their existence on certain definite conditions. A bacillus first demonstrated by Koch had the power under certain conditions to set up the disease known as tuberculosis. With the knowledge now available it was possible to maintain a nutritional level which could prevent the bacillus of Koch from multiplying in the human or animal body.

By using the knowledge available about the bacillus of Bang a test had been devised by which it was possible to ascertain whether or not any particular cow harboured it. After many years' experience with this test we knew that many pregnant cows could prevent it causing infertility. Was this ability of many cows to defend their normal functions determined by nutritional influences? The knowledge was available to organise an investigation which could answer this question.

Dr. KENNEDY congratulated Mr. O'Connor on his lucid and concise treatment of a subject with such wide ramifications. He thought it should not be too lightly assumed that in this country serious mineral deficiencies were not prevalent. Colonel Doherty had given a few examples. It was well known that in mountain districts after bad hay years—and they were far from being unusual—there was a small calf crop. This was accepted as common knowledge in those districts. From certain American experiments it would seem to be occasioned by lack of minerals and vitamin A in the food of the cow. It was certainly something that required investigation. He joined with Professor Sheehy in hoping that new opportunities would be made available to the veterinary profession to elucidate the major and the local nutritional deficiencies occurring in this country.

Professor O'DEA offered Professor Sheehy his sincere thanks for doing them the honour of coming there that night to open the discussion. Some of the members there present might not be aware of the fact that Dr. Sheehy was one of the greatest authorities on animal nutrition in Great Britain or Ireland to-day. He had done an immense amount of work at the Albert College on nutrition and the mineral and vitamin requirements of cattle, pigs and poultry. It was surprising that his publications were not more frequently quoted, and he thought that was largely due to his retiring and modest disposition. Mr. O'Connor had apologised for not quoting him more freely, but he had noticed that, consciously or unconsciously, Mr. O'Connor had in many instances given almost *verbatim* the findings published by Professor Sheehy as a result of his researches.

The essayist had ably covered his subject in a general way and Professor Sheehy had dealt with the practical aspect of the matter, and had very properly pointed out that besides those individuals manifesting clinical symptoms, there were many others in the herd or flock which, although showing no external evidences of mineral deficiency, must be presumed to be affected in a lesser degree and consequently suffer from the natural effects—slower growth and development, diminished vigour and greater susceptibility to disease.

Everybody connected with the agricultural industry was concerned with the correction of these deficiencies in the soil, in the plant and in the animal. From the veterinary point of view treatment was often unsatisfactory and sometimes ineffective. Undoubtedly we could prevent the onset of symptoms by ensuring that the required amount of vitamin D was provided and by adding the necessary mineral supplements to the food. The addition of mineral supplements, however, had to be carried out more or less in haphazard fashion because we knew that a much smaller proportion of the mineral would be assimilated than if it were ingested in the organic form which nature intended —that was in the pasture and fodder: and who could say that the excess would not be deleterious to the organism? It must be assumed, therefore, that the place to counteract any deficiency was at the source.

Mr. O'Connor advocated the application of artificial manures to the pasture despite the warnings of Howard, Stapledon and others. While he agreed with him in the case of lands deficient in certain minerals, especially phosphorus and calcium, he was of opinion that the teaching of these men deserved respect and merited further investigation. In this field of the mineral requirements of plants and animals there was ample room for collaboration between the agricultural scientist and the veterinarian.

The Reply

Replying to the discussion, Mr. O'CONNOR stated that he would like to thank everyone for the way in which his paper was received and for the manner in which it was discussed by the various speakers. Owing to the lateness of the hour it would be impossible for him to refer to many of the points mentioned.

He was glad the speakers amplified his remarks, as there were many aspects of the subject with which he did not deal. He would like particularly to thank their very welcome visitor, Professor Sheehy, for kindly consenting to speak on the paper and giving them the benefit of his extensive knowledge on the mineral aspect of animal nutrition. Professor Sheehy, as everyone knew, was famous in the animal nutrition world and, therefore, he considered them fortunate in having a man of such repute to speak on this important subject.

Professor Sheehy's remarks were most informative and interesting. He had shown by his experimental studies the necessity of a properly balanced diet from the vitamin and mineral aspect in order to prevent rickets in animals and how it could be induced by improper management. It was gratifying to note that research on mineral nutrition in this country had proved its value conclusively. It was obvious that further research was required *re* animal feeding since some obscure conditions that practitioners met with might very likely to be due to a deficiency or excess of some mineral element in the diet resulting from a deficiency or excess in the soil, and in this respect as well as from the point of view of crops, a soil survey of the country was of primary importance.

Mr. O'Connor was glad that Professor Nicholson dealt with the physiological side of the subject, particularly in respect of calcium and phosphorus absorption and in the elucidation of tetany.

Colonel Doherty's remarks on the close association between soil fertility and animal fertility were very enlightening, as also were his experiences of an aphosphorosis occurring in cattle in Ireland. Mr. O'Connor thoroughly agreed with Colonel Doherty on the importance of soil fertility and recommended that something in the nature of a soil advisory scheme should be carried out.

Professor O'Dea had given some interesting data on the irradiation of milk. He also mentioned soil fertility and its relation to the application of humus. Mr. O'Connor mentioned that there was very interesting reading on the value of humus towards soil fertility in Howard's Agricultural Testament, which was an excellent treatise on the subject.

CLINICAL COMMUNICATION

Recovery from Gas Gangrene in the Dog

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Few cases of gas gangrene in the dog have been reported, and experienced clinicians agree that it is infrequent. Experimental work has been recorded 2, 4, 6, 7, 8, 16 and somewhat incomplete details of ten naturally occurring cases (in Europe and U.S.A.) are available. Of these latter, eight dogs died and one recovered from two separate attacks after serum treatment. 3, 5, 9, 12, 13, 14, 15, 17 The following further points emerge from the literature:—

(1) The dog is susceptible to infection with *Clostridium chauvoei, welchii, oedematiens, septique, histolyticum* and *tetani.* In general the susceptibility to these organisms is low and spontaneous recovery has occurred after experimental infection with *Cl. welchii* and *chauvoei.*

(2) *Cl. welchii* has been isolated from the muscles of normal dogs and the disease has been produced experimentally by the introduction into muscle tissue of sterile preparations of liver extract, bile, bile salts and pancreas.

(3) Natural cases may be idiopathic but usually result from bites or extensive wounds, operative interference or parenteral injections, involving the usual aseptic precautions.

(4) Of the natural cases studied bacteriologically, *Cl. welchii* was isolated three times ("Type II" specified once) and *Cl. oedematiens* once. Staphylococci, streptococci and *Cl. sporogenes* may or may not be present.

(5) Clinically, the disease has a short incubation period, is rapid in onset and collapse quickly ensues, with a varying degree of pyrexia, injected mucous membranes and rapid pulse. The local lesion is usually superficial and shows very painful swelling, a slight brown foetid discharge and often crepitation. Untreated cases usually die within a few hours but may linger for three days.

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The following case concerns a dog that recovered from clinical gas gangrene, having received the same routine treatment that is now recommended for man, namely, the early commencement of serum treatment, sulphonamide therapy and surgical interference.

Subject.—Wire-haired fox terrier, male, aged 5 years weight 20 lb.

History.—The dog was bitten in the inguinal region during a fight on the morning of 27.2.44, and was carried home where he lay declining to move and refusing all food. He vomited twice and remaining dull next day with continued anorexia, was admitted on the evening of 28.2.44 for observation.

Examination (28.2.44 p.m.).—The dog was very dull and could barely stand but greatly resented examination of the inguinal region. There was dehydration and the mucous membranes were congested. T. 101·2° F., P. 120, R. 30.

Medium anaesthesia was induced with nembutal 4½ grains intravenously and 280 ml. 5 per cent. glucose saline was administered intravenously. There were two punctured wounds on the right side, one just lateral to the bulb of the penis and the other immediately in front of the stifle. These were probed and drainage established. No sinuses could be found and the peritoneum was thought not to be pierced, but there was a very severe cellulitis extending up the flank from the penis to the external angle of the ilium. A little blood-stained fluid could be squeezed from the wound, which had a very strong and objectionable odour. The bladder was found to be empty on catheterisation.

3½ grammes of sulphapyridine was administered by stomach tube.

Course: 29.2.44 a.m.—The dog had recovered consciousness but was unable to sit up. Mucous membranes still congested. Wound very painful. Distinct crepitus in the flank. Smears of the wound discharge showed mononuclear cells, large numbers of Gram positive cocci and an equal number of short fat Gram positive rods. Blood examination showed: R.b.c. 6,560,000 per cu. mm., W.b.c. 18,000 per cu. mm., Polymorphs 83 per cent., Lymphocytes 12 per cent. and Monocytes 5 per cent. T. 100·4° F., P. 150, R. 30.

Sulphapyridine ½ gramme per os. Five and a half ml. of mixed sera were given intravenously at midday (*Cl. welchii* serum, Type A 5 parts, Type C 2½ parts, Type D 2½ parts and concentrated tetanus antitoxin 1 part).

Cl. welchii, Type A, producing a weak *a* toxin, was subsequently isolated from the wound discharge on anaerobic culture.

29.2.44 p.m.—The dog was brighter and was just able to walk a few steps. He had eaten a little. Mucous membranes still congested. Halitosis. Right flank still hot, painful and showing crepitus. T. 100° F., P. 152, R. 32. No micturition or defaecation since admittance.

½ gramme sulphapyridine introduced into the wound, that outside being licked off by the dog.

1.3.44 a.m.—Marked clinical improvement. Able to run about though lame in the right hind leg. Eating. Wound less painful and discharging yellow fluid pus, consisting chiefly of polymorphs with *Cl. welchii* and cocci still in abundance. Mucous membranes almost normal. T. 101·5° F., P. 140 and stronger, R. 40. Urinated for the first time (about 4 ounces): S.G. 1020, reaction acid, colour bright yellow, showing albumin, bile salts, a trace of indican and about 4½ per cent. sugar. 280 ml. 5 per cent. glucose saline and 2·75 ml. mixed sera intravenously.

½ gramme sulphapyridine introduced into the wound.

1.3.44 p.m.—No further improvement. Defaecated for the first time. T. 100·6° F., P. 100, R. 38.

½ gramme sulphapyridine introduced into the wound.

2.3.44.—Wound still less painful and was irrigated with 5 per cent. saline solution, which removed some yellow fluid pus. Refused evening meal.

	February							March								
	28th	29th		1st		2nd		3rd		4th		5th		6th		7th
	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.
Temperature	101·2	100·4	100	101·5	100·6	101·6	102·3	101		101·6		101·6	100·2	101		101·5
Pulse rate per min.	120	150	152	140	100	108	120	80		100		74	104	120		104
Respirations per min.	30	30	32	50	38	36	40	32		36		26	25	30		30
Urine																
Quantity (approx.)		Anuria		4 oz.	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.	4 oz.
Colour		"							Bright	Orange	Yellow					
Specific gravity		"		20	24	30	30	40		36		30		40		50
Reaction		"		ac.	ac.	V.ac.	ac.	ac.		ac.		ac.		ac.		ac.
Sugar (approx. %)		"		4	4·5	½	½	½		½		—		—		—
Acetone		"		—	—	+	±	—		tr.		tr.		tr.		—
Albumin		"		+	—	—	—	—		—		—		—		tr.
Blood		"		—	—	—	—	—		—		—		—		—
Bile salts		"		+	+	+	+	tr.		+		+		+		+
,, pigments		"		—	—	—	—	—		+		+		+		+
Indican		"		±	—	—	—	—		—		—		—		—
Blood																
Haemoglobin value (Haldane)		—				—										100%
R.b.c. per cu. mm.		6·56 million				6·78 million										6·85 million
W.b.c. per cu. mm.		18,000				9,200										11,750
Polymorphs		83%				77%										79·5%
Lymphocytes		12%				12%										15·5%
Monocytes		5%				9%										4·5%
Eosinophils		—				2%										—
Basophils		—				—										0·5%

Sulphapyridine (6½ grammes)

Glucose saline

Serum

2·75 ml. mixed sera intravenously and 2×½ gramme sulphapyridine introduced into the wound.

3.3.44.—Bright and active. Running willingly though still lame. Stifle wound healed.

4.3.44.—Wound discharging some pus, but now firm and quite painless.

6.3.44.—Lameness now very slight. Some thickening of the subcutaneous tissues around the wound. Slight balanitis.

12.3.44.—Dog in good health, very frisky and not lame. Wound near the penis almost healed.

Subsequent recovery was uneventful.

Remarks.—The clinical diagnosis of gas gangrene seems to be justified by the bacteriological findings and the response to treatment, and although it was possible that spontaneous recovery might have occurred, the improvement following serum therapy was sufficiently dramatic to make this appear unlikely. It is unfortunate that a urine sample could not be obtained before the glucose saline was given as it is now impossible to say whether glycosuria was a symptom of the disease. Glycosuria is known to occur in *Cl. welchii* Type D infection in sheep but it has not been reported in diseases due to other types. This dog was excreting approximately 4 per cent. sugar in its urine 36 hours after being given the glucose saline. Another wire-haired fox terrier, male, aged 3 years and weighing 17 lb., was given a similar quantity after an operation and within half an hour was excreting approximately 7 per cent. sugar, but 15 hours later its urine was devoid of copper reducing substances. Possibly the toxaemia present in the first dog was responsible for the continued excretion of glucose. Glycosuria has not been encountered in several other dogs examined during and after nembutal anaesthesia.

The absence of pyrexia whilst under observation is also of interest.

Acknowledgments.—I should like to thank Professor T. J. Bosworth for supplying the sera, Mr. J. J. Bullen, M.R.C.V.S., for advice and for carrying out the bacteriological work, and Mr. W. G. Macleod for examining the first blood sample.

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* * * * *

Artificial Insemination of a Bitch

Mr. James Jones, M.R.C.V.S., Lecturer in Surgery and Obstetrics, Veterinary College of Ireland, writes: "At the request of Mr. Frisby, M.R.C.V.S., Kilkenny, a greyhound bitch was sent to me to be artificially inseminated from a valuable stud dog 'Talis' which, though otherwise healthy, suffers from paresis, the result of an accident that occurred more than a year ago, and is unable to copulate.

"Semen (2 c.c.) was collected into a syringe and having been examined microscopically for viability, was injected into the uterus with the aid of a pipette. A tubular vaginal speculum facilitated the insemination. The bitch has whelped six healthy puppies—three dogs and three bitches."

REFRIGERATION ANAESTHESIA

Complete surgical anaesthesia induced by refrigeration of a limb to be amputated is practised in human surgery. A tourniquet that completely stops circulation is applied above the site of amputation and the refrigeration is accomplished with ice packs. The method produces a bloodless and shockless field and is pronounced advantageous in poor-risk cases—diabetes and arteriosclerosis—but numerous clinical applications have been suggested by the Department of Surgery of Stanford University.—*Annals of Surgery.*

* * * * *

Royal Veterinary College R.F.C.—The College 1st XV is in urgent need of football jerseys, and old members of the Fifteen willing to part with theirs are asked to communicate with the Hon. Secretary of the Club, Mr. D. Bowen, Streatley House, Streatley, Berks.

ABSTRACTS

[Some Observations on the Bionomics of the Itch Mite (*Psorergates ovis*) of Sheep and its Control with Lime-Sulphur Dips. Graham, N. P. H. (1943.) *J. Coun. sci. and industr. Res.* **16.** 206-214.]

Attention has recently been drawn to *Psorergates ovis*, a mite parasitic on sheep in Australia. Although flock owners had recognised the symptoms caused by the mite for up to 40 years previously, the ectoparasite was not recorded or described until 1941. There is, as yet, little definite information on the economic importance of the parasite but it appears that the degree of infestation in flocks varies from year to year and is generally higher in old than in young sheep. Moreover, the mite has a wide distribution and does not seem to be confined to any particular type of sheep although it has, at present, been observed only in merinos, since no extensive survey of cross-bred or long-wool sheep has been made. From experiments, Graham observed that transmission of the mite from machine-shorn to other shorn or unshorn sheep readily occurred while transmission from woolly sheep was infrequent and much slower, contact for some months being necessary. Under experimental conditions it was found that sodium arsenite solution containing 0·2 per cent. arsenic trioxide, or colloidal sulphur suspension containing 1 per cent. sulphur, or a suspension containing 0·005 per cent. rotenone was effective in killing a large proportion of the mites, although a few survived. Mites were, however, completely eliminated from infected areas by using a lime-sulphur solution containing 1 per cent. polysulphide sulphur, to which was added 0·03 per cent. Agral 3 as a wetting agent and which improved the rate of penetration of the dip into the fleece. Field trials with the lime-sulphur dip involving approximately 10,000 sheep were carried out and the examination of skin scrapings, taken from certain marked sheep at intervals for a period of eight months after dipping, showed that mites could not be found on the marked sheep at any time after the dipping except for a limited period in those situations in which complete wetting was difficult to achieve. The polysulphide-sulphur content of the dip remained within effective limits throughout the dipping of large numbers of sheep. It is, however, noted that if the liquid is swallowed death occurs very rapidly and six out of the 10,000 sheep were lost from this cause; care, therefore, is necessary in handling sheep, particularly weak ones, in the dip.

J. N. O.

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[Contribution to the Study of Endocarditis in Swine. Bouvier, G. (1944.) *Schweiz. arch. Tierhlk.* **86.** 22-32.]

The author describes in detail the pathological and bacteriological findings in 18 cases of endocarditis in swine. The mitral valve showed lesions in 17 cases, the tricuspid valve in four, the aortic valve in four, and the pulmonary valve in one. *Erysipelothrix rhusiopathiae* was present in 14 cases, in three cases accompanied by streptococci, and in one by *S. cholerae suis*. In three cases, streptococci alone were present in the lesions, and in one case *Bact. coli* alone was isolated.

E. C.

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[Clover Sickness, or Trifoliosis. Morrill, C. C. (1943.) *N. Amer. Vet.* **12.** 731-732.]

The condition described is believed to be aetiologically similar to trefoil dermatitis of sheep in Australia. It occurs in cattle pastured on legumes, especially the white clovers, and in horses pastured on alsike clover, most cases occurring at periods characterised by cold rainy nights and warm sunny days. Dermatitis and stomatitis are the outstanding features, but many other symptoms, including gastro-intestinal disturbance, jaundice, haemoglobinuria and even haematuria have been reported. [No indication is given as to whether the urinary pigments have been adequately studied.] In a given animal, the unpigmented skin appears to be more susceptible than the pigmented, suggesting that photosensitisation is involved.

Treatment consists of removal from the offending pasture, avoidance of bright sunlight, and appropriate symptomatic measures.

A. N. W.

Weekly Wisdom

"*. . . The preachers of totalitarian solutions of any kind are reminded of the political realities that these solutions involve, of the risk of moral degradation that is inherent in Caesarism, whatever label it may wear to-day. Communities have a ratio that cannot be weakened without deadly peril to the citizens of the community—and its neighbours. We are our brother's keeper.*"—"Tracts for the times." *Times Lit. Supp.* 1944. August 19th. 405.

REVIEWS

[A Scientific Policy for British Agriculture. (Parliamentary and Scientific Committee.) Price 9d.: on sale at booksellers.]

The Parliamentary and Scientific Committee of the Houses of Parliament contains important elements of both Houses, as well as representatives of many scientific and technical institutions. The veterinary profession is well represented in this latter category.

The views of so important a body, now published in a pamphlet available to all, will therefore demand serious consideration by all who are interested in that hitherto nebulous and dubious infant "post-war Agricultural Policy."

It is obvious that the Committee recognises the important part that veterinary science has to play in these matters. Emphasis is placed on the need for control of disease (pp. 4, 9 and 13), education and research (pp. 7, 13 and 14). In the matter of research it is pointed out in para. 48 on p. 14 that, in view of the agricultural output of some £250 millions a year, a research bill of £600,000—one quarter of one per cent.—is but slender. The Committee recommends that this should be not less than £3 million a year. The 16 pages of this pamphlet are well worthy of careful study and thought by all interested in the agriculture of to-morrow.

* * * * *

[Horses of Britain. By Lady Wentworth. Pp. 47, with 8 plates in colour and 26 illustrations in black and white. William Collins, 40, William IV Street, London, W.C.2. Price 4s. 6d.]

This book might provide a useful introduction to a knowledge of our breeds of horses when placed in the hands of the veterinary student in his earlier years. The work is copiously illustrated, but we consider some of the illustrations might have been more carefully chosen with a view to revealing the distinctive conformation of the various breeds. Many of them are selected more for their pictorial interest than for their value to the student of the subject.

NOTES AND NEWS

The Editor will be glad to receive items of professional interest for inclusion in these columns.

Diary of Events

Sept. 20th.—Meeting of the Finance and General Purposes Committee, N.V.M.A., at 36, Gordon Square, W.C.1, at 11.30 a.m.

Sept. 20th.—Meeting of the Lancashire Division, N.V.M.A., at Preston (Booth's Café), 2.30 p.m.

Sept. 21st and 22nd.—Meeting of the Survey Committee, N.V.M.A., at 36, Gordon Square, W.C.1, at 11.30 a.m.

Sept. 27th.—Meeting of the Western Counties Division, N.V.M.A., at Exeter (Guildhall), 2 p.m.

Oct. 4th.—Meeting of the Ayrshire Division, N.V.M.A., at the Hannah Institute, 2.30 p.m.

Oct. 16th.—R.C.V.S. Committee Meetings, 10, Red Lion Square, W.C.1.

Oct. 17th.—R.V.C.S. Committee and Council Meetings, 10, Red Lion Square, W.C.1.

Oct. 18th.—R.C.V.S. Quarterly Council Meeting, 10, Red Lion Square W.C.1.

Oct. 19th and 20th.—N.V.M.A. Annual Meeting, Council Meetings and Demonstrations, in London.

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N.V.M.A. Annual General Meeting, 1944

As announced in our last issue, in view of unforeseen local difficulties, the venue and dates of the Annual General Meeting have been changed.

The meeting will now take place at the Connaught Rooms, Great Queen Street, W.C.2, on Thursday, October 19th, 1944, at a time to be notified later.

It is hoped to arrange for the proposed programme of operations and demonstrations to take place on the following day, October 20th, at the Royal Veterinary College, Camden Town, N.W.1.

Council Meetings are also being arranged for October 19th, details to be published later.

Members who intend coming to these meetings are strongly advised to book rooms *without delay*.

PERSONAL

Southern Rhodesian Appointments

The appointment is announced, as Chief Veterinary Surgeon for Southern Rhodesia, of Captain Percy Douglas Huston, R.A.V.C. (S.R.) (retd.), who qualified at Dublin on December 15th, 1914.

Mr. John Salmond Adamson, B.Sc. (Edin.), M.R.C.V.S., D.T.V.M. (Edin.), who qualified at Edinburgh on July 19th, 1926, has been appointed Assistant Chief Veterinary Surgeon.

Other appointments recently made by the Colonial Office include that of Mr. I. McAdam, B.Sc., M.R.C.V.S., as Veterinary Surgeon, Tanganyika Territory.

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Births.—Brown.—On September 7th, at Crown Hotel, Kirkoswald, Penrith, to Evelyn (*née* Westgarth), wife of Alexander Brown, M.R.C.V.S., a daughter.

Hickman.—On August 30th, 1944, at the Rubislaw Nursing Home, Aberdeen, to Beryl (*née* Davies), wife of Major John Hickman, Royal Army Veterinary Corps, a daughter (Celia Vaughan).

Pettett.—On August 28th, 1944, to Ina, wife of D. W. S. Pettett, M.R.C.V.S., at the Ebberly Nursing Home, Barnstaple, a brother for Jillian (John Quilter).

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Marriages.—Jones—Reedman.—On September 4th, 1944, at Heathfield Road Welsh Methodist Church, Liverpool, Eric Benjamin Jones, B.V.Sc., M.R.C.V.S., eldest son of Mrs. Margaret Jones and the late Mr. E. W. Jones, Bethesda, Caernarvonshire, to Cecilia Pearl Reedman, S.R.N., S.C.M., late Sister, Liverpool Maternity Hospital, youngest daughter of the late Mr. and Mrs. F. C. Reedman, Rangoon, Burma.

Walker—Hearn.—On September 2nd, 1944, Cyril W. M. Walker, M.R.C.V.S., to Nancy E. Hearn.

Watt—Chadwick.—On March 18th, 1944, at St. George's Church, Baghdad, Captain Wallace Gordon Watt, Q.V.O. Corps of Guides, F.F., the only son of Mrs. L. M. Watt, of Westview, St. Andrews, Fife, to Aileen Elizabeth Marion Chadwick the only daughter of Major C. R. Chadwick, O.B.E., M.R.C.V.S., Inspector General of Veterinary Service, Iraq.

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Colonel and Mrs. Head Bereaved.—Deep sympathy will be extended to Lieut.-Colonel A. S. Head, C.M.G., J.P., F.R.C.V.S., and Mrs. Head, of Helston, Cornwall, in the death in a Cornish Military hospital, from the effects of war service, of their second son Major John Alfred Head, of the Royal Artillery. Joining the Territorial Army in 1938, he was commissioned Lieutenant and on the outbreak of hostilities he was called for active service. He did good service as a gunnery instructor. For two years Major Head, who thus qualified for the African Star, was in the siege of Malta, where the privations he had to undergo undermined his health. He had been in this country about a year and had resumed his work as gunnery instructor.

In addition to his widow, he leaves one daughter. His two brothers Captain C. S. Head, M.C., Commando Corps, and Lieut. R. G. Head, Royal Marines, are both on active service. Captain Head was severely wounded, but has made an excellent recovery.

The *Cornwall Advertiser* describes Major Head's passing as a particularly severe loss to Mullion, where he was in pre-war days one of the best-known and most popular residents. Keenly interested in young people and a talented sportsman, Major Head would have been one of the leaders in local affairs in the post-war era.

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R.C.V.S. OBITUARY

Park, Jonathan, Wigton, Cumberland. Graduated Edinburgh December 21st, 1892. Died August 23rd, 1944.

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LONDON CENTRE FOR SCIENTISTS

The Society for Visiting Scientists, with premises at 5, Old Burlington Street, W., has been founded to provide a centre for overseas scientists visiting Britain.

This Society has been formed on the initiative of the British Council, in consultation with the Royal Society, and at an informal reception in the well-appointed premises, Professor F. G. Donnan, President of the Society, said that it was an important part of the working committee's plan to set up in the Society's house a bureau of information which would be at the disposal of all visiting scientists for the purpose of advising them in connection with British scientific societies and institutions, and helping them to get in touch with British colleagues in their various spheres of work.

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EXHIBIT LINK WITH PROFESSOR DICK

At the June meeting of the Scottish Metropolitan Division, N.V.M.A., Professor Matheson exhibited a specimen of considerable historical interest; this was a laminated biliary calculus from an aged sow together with the original letter sent with the specimen

to the late Sir Charles Gordon and handed by him, for inspection, to the late Professor Dick. The letter was as follows:—

COPY

Buchan, near Huntly.
February 19th, 1838.

Dear Sir Charles,

I beg to send you for the inspection of Mr. Dick and for your Museum a calculus found in the gall-bladder of an aged sow slaughtered here about ten days ago, which I am informed by the Veterinary Surgeon of Huntly is a very extraordinary natural curiosity and of a size uncommonly large. The sow was littered here about 12 years ago and kept for breeding and had a litter of pigs in the month of October last. After suckling them the usual time she was put up to be fed off. She throve remarkably well and was in the best condition when killed, weighing about 14 stones Dutch and in a perfectly healthy state.

I am,
Dear Sir Charles,
Yours most faithfully,
(Sgd.) Jno. Gordon.

Sir Chas. Gordon.

Dick had placed the letter in the same receptacle as the calculus and sealed the container. The specimen was discovered by Professor Matheson some years ago when rearranging the pathological museum of the College.

With time the calculus has crumbled into pieces, several of which are, however, large enough to exhibit a distinct lamination.

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POWERS OF DDT

In a recent issue *The Times* gives further details of the powerful synthetic multi-purpose insecticide DDT, which has stopped a typhus epidemic, threatens the existence of the malaria-carrying mosquito and household insect pests, and is capable of controlling many of the insects which now do untold damage to food crops.

The insecticide is "p:p'-dichloro diphenyl-1:2:3-trichloroethan." It is lethal to the body louse, which transmits typhus fever to man; and is capable of killing mosquitoes, thus helping to control the spread of malaria. Dysentery, enteric, cholera, and the plague will be capable of better control than heretofore, because DDT is deadly towards the various species of flies, while it has already been used successfully to destroy bugs, fleas, cockroaches, beetles, cabbage worms, apple-codling moths, and aphides. On insects it acts both as a contact and as a stomach poison, although it is non-toxic to man and other warm-blooded animals in the concentrations normally used. It also has the remarkable property of being effective for many weeks after application. A swamp properly treated may be freed from breeding mosquitoes for a considerable period.

The first full-scale use of DDT in a war sector was in Naples, where, last December, typhus broke out in the overcrowded civilian population, which in the main was poverty stricken, dirty, and louse-ridden. As soon as the allied forces were in control vigorous steps were taken to suppress the outbreak by mass disinfestation. This was first done by dusting with non-DDT-containing lousicides, but as soon as DDT became available it was used solely and with signal success: never before has a typhus outbreak been arrested in mid-winter. British troops going to the Continent now have a standard issue of DDT-impregnated shirts, which effectively protect the wearer against lice for two months, even after regular washing. For the troops protection against malaria and dysentery is even more important, and in the operations which are being carried out in the Far East DDT will have its most important war use.

Although DDT was first made in 1874, it was not heard of again until 1939, when J. R. Geigy, of Basle, the Swiss dyestuffs company, found that it killed bugs and later used it to check the plague of potato beetle in Switzerland. The British branch of the Geigy company brought this compound to the notice of the British Government in 1942.

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FOOT-AND-MOUTH DISEASE

At the week-end foot-and-mouth disease was confirmed among cattle and pigs at Soothill, Batley, Yorks, West Riding.

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WINTER RATIONS FOR LIVESTOCK

Next winter's rationing arrangements show few changes from those of last winter, and full details are given in a leaflet being issued to all farmers.

Dairy Herds.—Rations during the winter months (October to April inclusive) will continue to be based on milk sales two months previously. The monthly allowance will be one unit of protein and two units of cereals for each 80 gallons of milk sold in excess of 15 gallons per cow per month, subject to a deduction of 48 lb. of cereals per cow per month. This means that the farmer is expected to provide, in addition to maintenance, protein for the first half gallon, and cereals, *i.e.*, feeding grains or their cereal equivalent in other fodder crops, for approximately the first gallon per day.

Pigs and Poultry.—Winter ration scales commenced on September 1st, and basic rations will remain unchanged as compared with last winter. Coupons valid for the purchase of chick food between January and April, will be issued in November, but autumn coupons may be obtained in lieu of spring coupons if application is made before the end of October. Rations for pedigree pigs and farrowing sows remain unchanged: an allowance of protein will be available for premium boars being used for service.

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SCHEME FOR THE CONTROL OF DISEASES OF DAIRY CATTLE

Statement showing the Number of Undertakings notified to the Ministry of Agriculture during the Month Ended August 31st, 1944

County	Undertakings Notified		Total Undertakings		
	During Month	Previously	Number	Number of Cattle	
				Cows	Heifers
ENGLAND					
Bedford	1	41	42	976	538
Berks	1	103	104	3,547	2,173
Bucks	1	93	94	3,281	1,770
Cambridge	—	15	15	353	208
Chester	5	401	406	13,281	4,550
Cornwall	—	8	8	158	105
Cumberland	—	65	65	1,618	1,411
Derby	5	323	328	9,439	5,323
Devon	5	275	280	4,214	2,496
Dorset	—	70	70	2,162	1,163
Durham	1	284	285	6,272	2,182
Essex	4	254	258	9,197	5,337
Gloucester	1	108	109	3,172	1,814
Hampshire	4	405	409	11,604	7,682
Hereford	—	25	25	359	231
Hertford	—	78	78	2,346	1,434
Hunts	—	14	14	475	315
Isle of Ely	—	3	3	83	75
Isle of Wight	—	14	14	252	127
Kent	1	154	155	3,952	2,270
Lancs	—	206	206	5,886	1,847
Leics	1	98	99	2,549	1,747
Lincs (Holland)	—	3	3	25	11
Lincs (Kesteven)	—	25	25	334	142
Lincs (Lindsey)	—	105	105	1,999	1,113
Middlesex	—	16	16	641	307
Norfolk	2	191	193	5,840	4,054
Northants	2	82	84	2,303	1,754
Northumberland	2	65	67	2,312	1,112
Notts	1	157	158	3,525	2,091
Oxford	—	43	43	1,271	1,145
Rutland	—	8	8	138	91
Salop	2	276	278	8,409	4,057
Soke of Peterborough	—	1	1	37	31
Somerset	—	241	241	6,187	2,876
Staffs	1	217	218	6,373	3,414
Suffolk, E.	2	95	97	2,259	1,651
Suffolk, W.	—	51	51	1,054	631
Surrey	—	110	110	3,145	1,451
Sussex, E.	—	179	179	4,614	2,613
Sussex, W.	1	141	142	3,829	2,198
Warwick	3	135	138	3,420	2,088
Westmorland	—	14	14	414	506
Wilts	—	93	93	3,765	1,785
Worcester	4	162	166	3,461	1,580
Yorks, E.R.	—	103	103	1,591	912
Yorks, N.R.	—	118	118	2,356	1,458
Yorks, W.R.	2	271	273	6,640	2,568
WALES					
Anglesey	4	44	48	836	611
Brecon	—	9	9	199	108
Caernarvon	—	112	112	1,791	968
Cardigan	1	28	29	511	358
Carmarthen	—	242	242	4,297	2,195
Denbigh	—	60	60	1,289	641
Flint	—	118	118	2,610	1,155
Glamorgan	1	99	100	1,653	639
Merioneth	—	10	10	125	68
Monmouth	2	53	55	1,317	776
Montgomery	1	17	18	332	243
Pembroke	1	85	86	1,630	1,146
Radnor	—	—	—	—	—
TOTALS	62	6,816	6,878	177,838	95,365

Notes.—(1) Operative periods of undertakings: 1 year, 1,361; 2 years, 608; 3 years, 4,909. (2) Undertakings renewed for a further period: 1 year, 630; 2 years, 135; 3 years, 126. (3) Undertakings not renewed at end of operative period, 374. (4) The figures showing the number of undertakings notified during the month relate to entirely fresh undertakings and do not include undertakings renewed for a further period.

Undertakings which have been cancelled or not renewed are not included in the figure for previous notifications.

County	Undertakings Notified: During Month	Undertakings Notified: Previously	Total Undertakings: Number	Number of Cattle: Cows	Number of Cattle: Heifers
SCOTLAND					
Aberdeen	—	27	27	1,218	422
Angus	—	21	21	812	395
Argyll	—	6	6	113	115
Ayr	—	39	39	1,257	955
Banff	—	4	4	121	42
Berwick	—	2	2	53	22
Bute	—	—	—	—	—
Caithness	—	—	—	—	—
Clackmannan ..	—	6	6	180	148
Dumfries	—	14	14	744	613
Dumbarton	—	3	3	105	86
East Lothian ..	—	3	3	145	88
Fife	1	34	35	1,379	626
Inverness	—	10	10	349	192
Kincardine	—	5	5	231	126
Kinross	—	3	3	59	32
Kirkcudbright ..	1	16	17	1,032	736
Lanark	—	20	20	683	486
Midlothian	—	1	1	44	69
Moray	—	—	—	—	—
Nairn	—	1	1	14	—
Orkney	—	—	—	—	—
Peebles	—	4	4	54	21
Perth	—	33	33	752	428
Renfrew	—	9	9	384	297
Ross-shire	—	3	3	89	65
Roxburgh	—	—	—	—	—
Selkirk	—	—	—	—	—
Stirling	—	29	29	848	648
Sutherland	—	3	3	52	34
West Lothian ..	—	1	1	23	18
Wigtown	—	26	26	1,714	885
Zetland	—	—	—	—	—
Totals ..	2	323	325	12,455	7,549

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MINISTRY OF AGRICULTURE NEWS SERVICE

Cattle Diseases Control Scheme.—Mr. F. H. Gardner, formerly lecturer in Animal Husbandry, Cambridge University, in an address at a recent farm demonstration under the Surrey W.A.E.C., said that many herds in the country were in much the same state as a mixed sample of wheat. Cross-bred and unthrifty cows needed to be winnowed out and numbers of herds required treating for such diseases as contagious abortion, mastitis, sterility and Johne's disease. Farmers who put their cows on the panel under the scheme agreed between the National Veterinary Medical Association, the National Farmers' Union and the Ministry of Agriculture are assured that their herds will be regularly treated for these diseases and that the cows' health and milk supply will be greatly increased. Up to the end of July 6,760 farmers in England and Wales had taken advantage of this scheme.

. . . . .

The Bull.—Dairy farmers these days go to a great deal of trouble to verify the milking ancestry of the bulls they employ to raise the standard of milk production of their herds. It is well worth while therefore taking trouble also to see that the bull is suitably housed, happy and contented. To keep a bull in good condition and to help him lead a long and fruitful life it is essential that he should have plenty of exercise, air and sunshine and a diet arranged to keep him in good order, not over fat. This means giving him proper amounts of green food.

His pen should not be an old dark and dilapidated building that happens to be handy or just a stall at the end of the cow shed; it should be a sound, well-constructed shed about 12 by 14 feet in such a position that he can see everything that is going on around him. If from his pen he has access direct to an exercising yard, that is a great advantage.

The real value of a bull is not known until a number of his daughters have finished their first lactation and by this time he will be about five years old. Bad management and housing conditions may by then have led to his becoming bad-tempered, so necessitating his disposal before his worth could be proved.

. . . . .

Bull Breeding Scheme.—County War Agricultural Committees throughout the country have been urged to encourage the breeding of good dairy bulls by selecting and approving cows suitable for bull breeding when mated with satisfactory sires. With this in view dairy herds in East Sussex among other counties are subject to inspection by livestock panels of practical dairy farmers set up by the County War Agricultural Committee. To qualify as potential bull breeders under the East Sussex scheme the cows selected must, in a 315 days' lactation, give 600 gallons of milk with their first calf, 700 gallons with their second calf or 800 gallons with their third or any later calf. They must also satisfy the panel as regards breed-type and conformation. The committee subsequently issues a certificate of approval to bull calves born as a result of mating approved cows with a pedigree bull of the same breed that is entered in the Breed Society's herdbook and which possesses a milk recorded ancestry satisfying the requirements of the Breed Society.

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In 1944 the food stocks accumulated in the previous year, enabled food ships to be diverted for military use. Following on the landing in North Africa came the Italian campaign and then D-Day. Contrary to expectations, there was little attempt by the enemy to interfere with transport in this country and food distribution was not disturbed.—*Meat Trades Journal.*

CORRESPONDENCE

The views expressed in letters addressed to the Editor represent the personal views of the writer only and must not be taken as expressing the opinion or having received the approval of the N.V.M.A.

Letters to the Editor should reach the Office not later than by the first post on Monday morning for insertion in following Saturday's issue.

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"SOME CLINICAL DIAGNOSTIC METHODS OF USE IN CONDITIONS ASSOCIATED WITH ANIMAL PARASITES"

Sir,—In a paper by Miss Bingham, M.R.C.V.S., published in *The Veterinary Record*, August 26th, 1944, it is said (at the bottom of col. 1, p. 315) that coccidia can only be found in the faeces of a non-specific host when that animal is a carnivore. This, I feel sure, is an error, and would venture to say that, except for coccidia from the liver of a rabbit, it is in the highest degree improbable. The great majority of coccidia are parasites of intestinal epithelium and carnivora do not eat the intestines of their victims. In the course of nearly 40 years, during which time the number of samples of faeces examined must run into tens of thousands, I have encountered only one case in which coccidia were found in the faeces of a non-specific host. Some 14 years ago I found sporulated and unsporulated coccidia in the faeces of a foal—an animal which is not the host of any species of coccidium. Enquiry showed that the ground on which the foal was grazing teemed with rabbits. The parasites found conformed to the description of *Eimeria stiedae.*

In the same paragraph it is said, in effect, that in cases of doubt a diagnosis can be made *post-mortem* by examining frozen or paraffin sections of portions of the intestine to detect "damage done to the epithelial cells." It is perfectly certain that no amount of scrutiny of sections will enable one to identify "damage done to epithelial cells" as being caused by coccidia. What one may find is the parasite itself at some stage of development within the epithelial cells.

In the paragraph at the top of the second column of page 315 reference is made to putting coccidia into culture media. This is surely a misuse of the term, as no multiplication of the parasite occurs. The various liquids used simply maintain conditions in which sporulation will take place under laboratory control.

The methods described for the diagnosis of mange, for which no references are given, were described by me in the *Journal of Comparative Pathology and Therapeutics*, 1915, Vol. 28, p. 64, with a floatation modification in the same journal in 1923, Vol. 36, p. 273. The same volume contained my description of the sugar floatation technique for the collection of parasite eggs on page 266.

In "Questions and Answers" on page 318 of the same number of the *Record*, the opinion is expressed that follicular mange parasites would disintegrate within a short time of their death. This I think is open to question. In 1923 I found that Demodex, like Sarcoptes, would stand boiling in 20 per cent. caustic potash without disintegration and this would suggest that their outer structure is composed of chitin or some similar material. I showed in the *Journal of Comparative Pathology and Therapeutics*, 1926, Vol. 39, page 140, that Sarcoptes could retain its anatomical appearance in crusts from a horse's skin for 30 or more years. It would appear to be possible that this might hold good for Demodex.

I drew special attention in the article to the possible importance of the persistence of dead mange parasites in perfect anatomical condition. In a case of dispute much might hang on the question whether parasites found were alive or dead.

Yours faithfully,

Wroxton, Chorleywood, Herts. A. Leslie Sheather.

September 4th, 1944.

TREATMENT OF NEUROLYMPHOMATOSIS OF CHICKS

Sir,—Long illness and a recent major surgical operation have made it impossible to comment previously on the report by Mr. Asplin that chicks suffering from fowl paralysis (*Neurolymphomatosis gallinarum*) could be cured by the use of certain strains of sulphanilamide. In 1939-40 I made the observation that birds suffering from this disease were completely cured after two intraperitoneal injections of 5 c.c. of an aqueous solution of 10 per cent. potassium iodide, given on two successive days. There was no return of symptoms in the treated birds, and their progeny have shown no sign of the disease. A full report was made in the *Veterinary Journal*, October, 1940. Subsequent confirmation was provided independently by Dr. Tj. Bakker. The percentage total of complete recoveries was about 55.

In the report mention was made that alternative drugs had been used. One of them was a sulphanilamide compound which, as Mr. Asplin has found later, had no effect in relieving symptoms.

Further work was not continued in the absence of recognised support.

I shall be interested to hear the reason why two divergent substances apparently produce the same results.

Yours faithfully,

Hammersmith Hospital, W.12. Ernest Gray.

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FIRST-CALVER TRIPLETS

Sir,—Recently I delivered a first calving heifer of three dead heifer calves. Their aggregate weight was 160 lb., their respective weights being 58, 52 and 50 lb. I should be glad to know if these weights are not exceptional for triplets in a first calver.

Yours faithfully,

Brynrhedyn, Ferndale, Glam. D. R. T. Davies.
September 4th, 1944.

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VETERINARY EDUCATION: THE LOVEDAY REPORT

Sir,—Not so much for the information of the profession, which in the light of its experience sees and feels *that rock-like foundation* upon which the one-portal system rests, but more for the information of all persons and parties outwith the profession who, in virtue of office, shall deliberate upon and decide the destiny of that system, I ask leave to draw attention to two, of many, outstanding incidents of national importance—suggesting that such would be well advised to take the moral pointed to into consideration.

Arising from the War Emergency decentralisation of the Scottish Higher Leaving School Certificate, formerly one portal in nature, so marked have the inconsistencies of the multi-portal system become that schools and scholars have given public expression to unchallenged adverse criticisms; furthermore, we are informed that certain universities are now contemplating setting aside "Certificates of Educational Fitness" which formerly admitted to university education, and in lieu thereof setting preliminary educational examinations. Thus, in four years, the once formerly respected certification of education has fallen into such abject disrepute that it is honoured neither in person nor in purpose.

In the same period of history a no less traditional multi-portal system has gone by the board and, in so doing, has given Britain the most efficient army she, nay the world, has ever known. In the past self-election on the part of the individual and self-interpretation of the Manuals of Training on the part of Unit Commanders led to individual and national weaknesses which are better left buried with the dead past. Sufficient for me to point out that the initial step towards the achievements of to-day was the abolition of the multi-portal systems of H.M. Forces and the introduction of a one-portal system of selection and training.

War has always taught its own lessons; lessons purchased by the nation at great price. May you, who are charged with considering the proposal that a multi-portal system take the place of the existing one-portal system, take into grave consideration the lessons war has taught and the price the nation has paid, as is written on the wall.

Yours faithfully,

6, Douglas Street, Glasgow, C.2. George Dykes.
September 3rd, 1944.

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THE FUTURE OF THE PROFESSION

Sir,—Those in safely established positions are prone to become exceedingly long-sighted and to favour long-term plans for the benefit of the world: we who have yet to be sure of our bread and butter would like to see some interest taken in the immediate future.

Those of us who have felt the pinch of unemployment as described by the Smiths (*Vet. Rec.* **56**. No. 23), contend that the first item on the agenda should be the rehabilitation in work of their own choosing of the large numbers in the profession who are at present perforce serving the Crown or filling stop-gap positions. While there will always be some willing to devote their lives to this, admittedly essential, field of work, others feel that private practice is their best method of serving the nation; practice in which one can expand one's knowledge, experience and usefulness unconfined by the supervision and restrictions of a bureaucratic Civil Service organisation.

When these immediate problems are settled we can all settle down to the discussion of that distant future that is so important. Then we can decide whether the country will be better served by progressive practitioners trained in the "Art and Science" by veterinary surgeons in a veterinary atmosphere, or by stereotyped civil servants trained by laymen in sterilised offices.

Why not await the result of the struggle between our sister profession and bureaucracy, a struggle in which both parties have the same goal of improving the nation's health? When we see whether the medical profession or the Civil Service is going to control human disease we will have a better idea whether it is worth our while to subordinate our interest in the health of animals and veterinary science to that self-interest which alone is left to a man once entangled in the hands of a Civil Service organisation. At present the profession seems to be light-heartedly assuming the precursors of those bonds.

Yours faithfully,

c/o Lloyds Bank, Bombay, India. P. K. Hall-Patch.
August 25th, 1944.

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BONES

Sir,—In the issue of your publication dated September 2nd, we have been interested to read among the items "Notes and News" reference to the inadvisability of throwing bones in their uncooked state to cats and dogs as well as farm animals.

There is another aspect to this matter which we would suggest might be stressed, and that is the wastage that is taking place from the manufacturing point of view on account of bones being diverted from their proper uses in the ways you mention. If those concerned in this wastage acted in accordance with the appeals from the Ministry of Supply and from their local municipal authorities these valuable bones, instead of being wasted, would be saved for our industry, which is extremely short. Large quantities of bones are having to be imported from abroad to make up the deficiency and in the meantime we are having considerable difficulty in meeting demands for our products, which consist of:—

Greases—for explosives lubricating oils, soaps, etc.,
Glues—used for a hundred-and-one war purposes, and
Fertilisers and Feeding-stuffs.

Yours faithfully,

B. W. Scott,
Assistant Purchases Manager.

British Glues and Chemicals. Ltd.,
Welwyn Garden City, Herts.
September 5th, 1944.

DISEASES OF ANIMALS ACTS, 1894 TO 1937, AND AGRICULTURE ACT, 1937 (PART IV).

Summary of Returns of Confirmed Outbreaks of Scheduled (Notifiable) Diseases

Period	Anthrax	Foot-and-mouth	Parasitic Mange*	Sheep Scab	Swine Fever
Aug. 1st to 15th, 1944...	5	16	—	1	89
Corresponding period in—					
1943 ...	6	2	—	1	24
1942 ...	10	92	—	—	15
1941 ...	12	1	2	3	24
Total Jan. 1st to Aug. 15, 1944	123	45	6	62	607
Corresponding period in—					
1943 ...	188	12	6	105	333
1942 ...	210	203	26	118	280
1941 ...	302	258	14	142	881

Note.—The figures for the current year are approximate only.
* Excluding outbreaks in Army Horses.